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Multi-UAV Coordination and Control Interface

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Abstract

The interest in missions with multiple Unmanned Aerial Vehicles (UAVs) has increased significantly in last years. These missions take advantage of the use of fleets instead of single UAVs to ensure the success, reduce the duration or increase the goals of the mission. In addition, they allow performing tasks that require multiple agents and certain coordination (e.g. surveillance of large areas or transport of heavy loads). Nevertheless, these missions suppose a challenge in terms of control and monitoring. In fact, the workload of the operators rises with the utilization of multiple UAVs and payloads, since they have to analyze more information, make more decisions and generate more commands during the mission.

This work addresses the operator workload problem in multi-UAV missions by reducing and selecting the information. Two approaches are considered: a first one that selects the information according to the mission state, and a second one that selects it according to the operator preferences. The result is an interface that is able to control the amount of information and show what is relevant for mission and operator at the time.

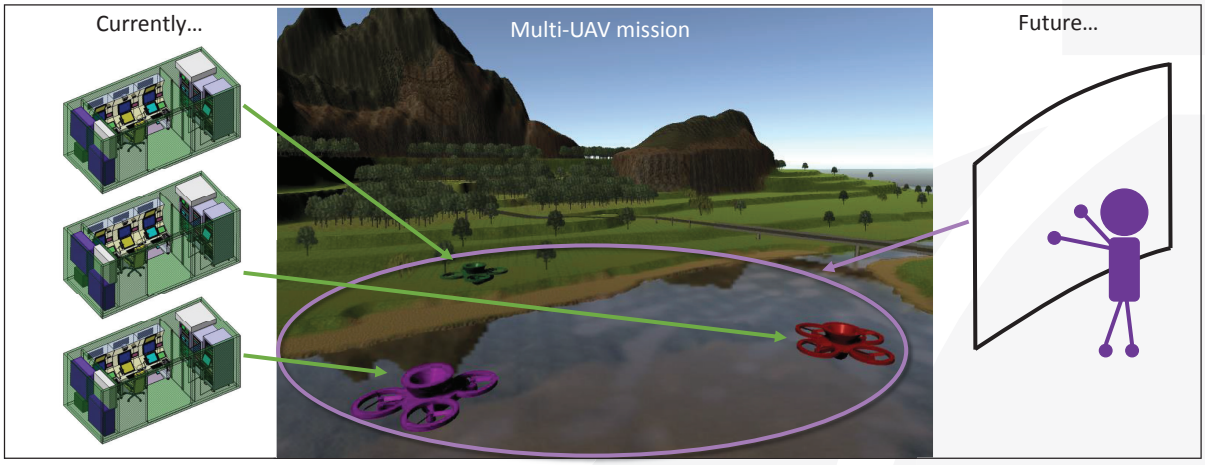

Figure 1: Current and future schemes for control and monitoring of multi-UAV missions.

Multi-UAV mission

A **multi-UAV mission** consists of a set of **resources** (both UAVs and payloads) that are allocated to some **tasks** (e.g. surveillance, capture and release, maintenance...) in order to achieve a series of **objectives** (fire surveillance, fire extinguishing...).

These missions generate a **huge amount of data** about the UAVs, payloads and scenario. Each UAV may generate a telemetry of around 10-100 messages and 100-1,000 variables depending on its size. Meanwhile, each payload may provide its own data: e.g. the images of cameras or the measures of sensors. Finally, the scenario may also generate data related to the tasks, their objectives, their status, etc.

Mission modeling

A **mission model** is required for monitoring the mission state and its possible evolution. This model allows **selecting the information** that is relevant according to the **mission state**.

In this work, the models are generated automatically from the experience of previous missions. The discovery algorithms of **process mining** are used to obtain **Petri nets** that represent the missions.

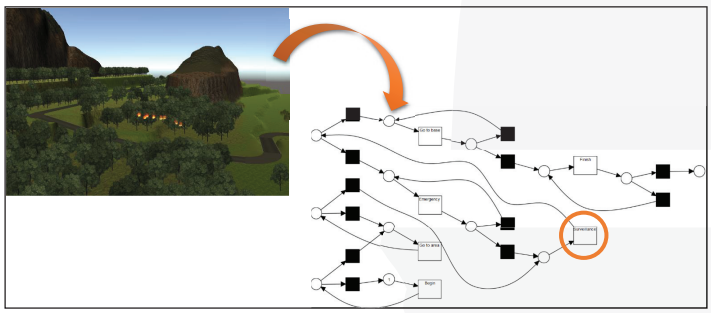

Figure 2: Monitoring of fire surveillance mission by using Petri net.

Operator behavior

On the other hand, this work is focused on the operator. Therefore, the selection of the information must be performed not only according to the mission but also according to the operator.

In this way, the information should be adapted to the physical and psychological **state of operator**. For instance, when the operator is stressed, tired or bored, the system should reduce the amount of data, in order to prevent saturation and errors.

In addition, the information should be adapted to the **preferences of operator**. For example, if the operator usually asks for a specific information in a certain state of the mission, the interface should anticipate the operator request and provide this information.

Interface

The expected outcome from this work is an **Intelligent Adaptive Interface** (IAI), which is able to change dynamically according to the context of the mission. This interface will have two parts: a static one with the information that must be shown permanently (e.g. mission map, current targets, available UAVs...) and a dynamic one with the information that is adapted to the context (e.g. system alarms, critical UAV data, important payload measurements...).